

Modelling the factor content of agricultural trade

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Abstract: This article examines the factor content of agricultural trade in the Central and East European (CEE) transition countries. It relates the factor content of agricultural trade to the cross-country differences in technology stemming from different farm organisations between the CEE countries agricultural sectors and to the differences in relative factor endowments. The relative factor endowments alone do not satisfactorily explain agricultural trade flows in the CEE countries. We find that transaction costs and market imperfections that affect the organisation of production also distort farm specialisation and hence the factor content of agricultural trade.

Key words: factor content, agricultural trade, comparative advantages, transaction cost

According to the general equilibrium models of international trade, countries trade with each other because of their differences or due to the increasing returns in production. The Ricardian model of international trade states that differences in technology between trading partners determine the trade pattern, while the Heckscher-Ohlin model asserts that countries trade because of the differences in the relative factor endowments. Countries with equal endowments and technology still trade, according to the new trade theory, if they specialize in different varieties of the same product. In this case, trade is driven by the increasing returns in production and product differentiation (Abo-Zaid 2010; Campbell 2010; Mitze 2010; Rashid and Razzaq 2010).

The commodity version of the Heckscher-Ohlin model, often called the Heckscher-Ohlin-Samuelson (HOS) model, predicts that a country will export those goods which require intensive use of the country's abundant factors, i.e., a relatively capital abundant country will export capital intensive goods while a relatively labour abundant country will export relatively labour intensive goods. The factor-content version of the Heckscher-Ohlin theory, the Heckscher-Ohlin-Vanek (HOV) model, on the other hand, deals with the factor content of trade rather than with the trade pattern of the individual products. Produced goods contain labour, capital or land services and export of goods involves also export of services of the factors of production. The HOV theory states that

countries will export the services of their abundant factors (Vanek 1968). This implies that in the capital abundant country, the capital labour ratio will be higher in production than in consumption, i.e. the capital abundant country exports capital services while the labour abundant country exports labour services (Leamer 1980).

The HOV formulation of the Heckscher-Ohlin theory has been extensively empirically tested. Empirical tests used mostly aggregate manufacturing data for developed countries. In the present paper, we estimate the factor content of the Central and East European (CEE)¹ agricultural trade. We are interested whether the CEE's agricultural trade follows the trade pattern suggested by the Heckscher-Ohlin theory. The focus on agricultural trade is motivated by the lack of similar studies in the literature. The Heckscher-Ohlin theory was tested on agricultural data only by Schluter and Lee (1978) and Lee et al. (1988) who used the US data, however.

The HOV model assumes an identical technology among the countries. This need not be the case in the CEE agriculture, however, and this has to be taken into account. Agricultural production in some CEE countries is concentrated on small individual farms (IF), while in other countries large corporate farms (CF) cultivate most of the agricultural land. Furthermore, in some CEE countries, there is a mixture of individual farms and corporate farms. The evolution of farm structures is the result of different

¹In the present study, the CEE refers to the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia.

privatisation and restructuring policies adopted in the individual CEE countries.

The choice between individual farms and corporate farms is based in the developed economies on relative efficiency of the farm organisation in the given production. Large corporate farms are more suitable for the capital intensive production, while individual farms are more efficient in the production of labour intensive agricultural commodities (Allen and Lueck 1998). The switch from one type of farm organisation to another is, however, very costly in the transition countries (Ciaian and Swinnen 2006), unlike the developed countries. This is due to the high transaction costs stemming from the poor functioning of some markets like the credit market or the land market in transition countries. The initial choice of privatisation and restructuring policies has therefore a strong impact on the farm organisation and the production of commodities in the long run. Countries that preserved large corporate farms are expected to specialize in the more capital intensive production than, *ceteris paribus*, countries that created individual farms by privatisation and restructuring.

The present paper makes three contributions to the existing empirical trade literature: (i) it extends the existing literature of the factor content of trade by specifically focusing on agricultural trade and including land among the primary factors; (ii) it attempts to identify the role of transaction costs as a driver of the agricultural trade flows; and (iii) it provides the first insights about the factor content of international trade in the CEE transition countries, which have been neglected in the previous literature.

LITERATURE REVIEW

Leontief (1953) was the first to test the Heckscher-Ohlin (HO) theory empirically. He found that the U.S. (the most capital-abundant country in the world) exported labour-intensive commodities and imported capital-intensive commodities, in contradiction with the HO theory.² Hence, the Leontief Paradox undermined the validity of the Heckscher-Ohlin theory. The Leontief Paradox has generated a huge litera-

ture in the subsequent years. The HOV theorem has been frequently rejected (and the Leontief paradox confirmed) for both the US and other developed economies.

The methodology used by Leontief and his followers has been criticised on many grounds (see e.g. Schott 2003 for an overview). Leamer (1980) showed theoretically that the paradox does not exist in the Leontief data if the possibility of unbalanced trade³ is allowed. However, even if the trade imbalance is correctly incorporated into the model, the Leontief paradox does not disappear entirely (Leamer 1984; Bowen et al. 1987).

From the perspective of this paper, there is an especially important criticism related to technology and omitting other factors of production from the empirical analysis. Leontief used a two-factor model (labour and capital), thus abstracting from other factors such as natural resources (land, climate, mineral deposits, forests, etc). Vanek (1959) pointed out that a commodity might be intensive in natural resources so that classifying it as either capital or labour-intensive would clearly be inappropriate. Vanek argues that the omitted factors help to explain the Leontief Paradox and he stresses the importance of restoring the traditional triad of capital, labour and land in the factor endowment considerations.

Stern (1975) also emphasised the need for models of more than two factors because capital and labour are required to improve natural resources to give them economic value, and countries may certainly combine these factors in somewhat different proportions when producing natural resource-based products. Thus, the consideration of natural resources is important in the examination of the effect of the factor endowment on trade.

The role of natural resources is especially important for agricultural production and trade in which land plays a crucial role. Leamer (1984) included agriculture in his study and included four types of land: tropical, arid, humid mesothermal and humid microthermal. Koo and Anderson (1988) use the Heckscher-Ohlin theory to empirically investigate the impacts of resource endowments (land, labour, capital, and technology) on agricultural exports in exporting countries. Koo and Anderson confirm

²Leontief calculated labour-output ratios and capital-output ratios for a number of industries in the U.S. economy. Using these coefficients, he then calculated the amount of labour and capital embodied in the U.S. imports and exports. Leontief found that the capital-labour ratio embodied in imports exceeded the ratio embodied in exports by approximately 30%.

³Unbalanced trade refers to a situation when imports differ from exports implying that trade and money flows are unbalanced. A country with unbalanced trade has trade deficit if its imports exceed export and trade surplus in the reverse case.

that land, labour, capital and technology determine agricultural trade.

In the Heckscher-Ohlin theory, trade is driven by the relative differences in factor endowments between countries. Countries are assumed to use the same technology, unlike in the Ricardian model where trade is driven by the differences in technology between the countries. The frequent failures of empirical tests of the HO theory were the motivation for incorporating technological differences into the model (Kielyte 2008). Technological differences were introduced either as differences in the matrixes of requirements of production factors to produce one unit of output or as adjustments to endowments due to the differences in productivity of factors (Trefler 1993 and 1995). The incorporation of technological differences improves the predictions of the HO model (Feenstra 2004; Kanacs 2007).

The literature analysing agricultural the factor content of the CEE trade is almost non-existent (e.g. Ferto 2005; Kanacs and Ciaian 2010a, 2010b). The CEE trade literature mainly focuses on describing the development of the CEE's imports and exports over time and in comparison with the EU. This literature indicates that both the structure and the composition of trade changed considerably over the transition period and as a result of the EU integration process (e.g. World Bank 2005; Svatoš and Smutka 2010). Other branch of studies on the CEE agricultural trade investigates the comparative advantage and trade specialisation for different commodity groups and trading blocks. These papers identify the dynamics in competitiveness and in specialisation patterns of the CEE trade with respect to their trading partners and in the context of the EU and/or regional trade integration (e.g. Bojnec and Ferto 2006 and 2008; Qineti et al. 2009).

Summarising the findings from the previous studies, we may draw several conclusions important for the present article. First, as the the Leontief's original study itself, most of the factor content studies to date have been applied to developed countries, because only these countries have the necessary input-output and trade data required for computing the factor content of trade for each sector and trading partner (Davis and Weinstein 2001). According to our knowledge, there is no single study analysing factor content in all CEE transition country trade to date. Second, there are very few studies examining the factor content of agricultural trade. Third, most of the previous studies have analysed the factor content and the relative endowment only of labour and capital. However, the findings of Vanek (1959) and Stern (1975) suggest that omitting other factors might yield biased factor content estimates.

The present article attempts to address all three issues of the previous studies. First, this article departs from the previous literature and examines the factor content in the CEE transition country trade, where the pattern of foreign trade may be affected by transaction costs of the farm reorganization. Second, the present study examines the theoretical predictions that relate the factor content of agricultural trade to the cross-country differences in the relative factor endowment. Third, in addition to the traditional factors such as capital and labour, our empirical analysis includes land.

DATA

Our study covers eight CEE economies (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia). In order to reveal the sectoral differences in the production and trade, we disaggregate the agricultural sector into eight sub-sectors. The three principal data sources are the COMEXT trade data from the Eurostat (2007), the GTAP 7 data base and the Farm Accountancy Data Network (FADN) farm survey data (FADN 2008). For the empirical analysis of the factor content of trade, we use the production and trade data for 2004.

The agricultural trade data are extracted from the COMEXT trade data base Eurostat (2007) and complemented by the GTAP 7 data base. The COMEXT data base provides trade data for all Member States of the EU on external trade with each other and with non-member countries. It contains data on external trade collected and processed by all EU Member States and more than 100 trade partners, including the USA, Japan and the EFTA countries. The COMEXT contains several types of data from various sources (European Union (EU), United Nations, IMF etc) and with different structures (corresponding to different nomenclatures such as CN, SITC Rev2, SITC Rev3 etc). In addition to the bilateral trade flows, the GTAP data provide the national input-output flows in the CEE and the data for macroeconomic variables such as consumption, GDP, etc, which together with the FADN data are used to calculate the factor input requirements.

HECKSCHER-OHLIN THEORY AND AGRICULTURAL TRADE IN CEE

Factor endowments in the CEE

The Central and East European countries differ in factor endowments (Table 1). In Table 1, land endow-

Table 1. CEE country factor endowment ratios

	Land/Labour (land/capita, ha)	Capital/Labour (euro/capita)	Agricultural labour (% of the total employment)
Czech Republic	0.36	4 078	9.6
Estonia	0.57	3 411	16.3
Latvia	0.71	3 283	19.5
Lithuania	0.76	2 929	18.0
Hungary	0.58	4 060	17.5
Poland	0.43	4 364	25.8
Slovenia	0.25	6 540	8.4
Slovakia	0.36	3 952	10.7
CEE	0.50	4 077	15.7

Source: Authors' calculations based on Eurostat and FAO (2008) data

ments are measured in hectares of agricultural land per capita, while capital endowments are measured in thousands of Euros of capital per 1 agricultural worker. Agricultural labour force endowment is proxied by the share of agricultural employment in the total employment in 1990.⁴

Of all CEE in our sample, Lithuania and Latvia are the most land abundant countries with 0.76 and 0.71 hectares of agricultural land per capita respectively. Slovenia is the least land abundant country with only 0.25 hectares of agricultural land per capita. The lowest ratio of capital per 1 agricultural worker is in Lithuania (2929 Euro/capita); the highest in Slovenia (6540 Euro/capita). Countries with higher GDP per capita have higher capital/labour ratios (Davis and Weinstein 2001). Slovenia was the most developed country in our sample in terms of GDP per capita and GDP in Slovenia is almost two times higher than in Lithuania.

The absolute labour endowment in terms of agricultural employment share in the total employment is reported in the column 4 of the Table 1. The smallest agricultural employment share in the total employment in 1990 was in Slovenia – 8.4%. Also in the Czech Republic and Slovakia, agricultural labour force was relatively small compared to the rest of

the CEE. The most farm labour abundant country was Poland, where in 1990 more than one quarter of all economically active workers was employed in agriculture.

To obtain the country's relative factor abundance, we compute the share of the country's factor endowment to the factor endowment in all CEE countries and the share of the country's gross agricultural output (GAO) to the GAO in all CEE. The relative factor endowment is then the ratio of the share of the country's factor endowment and the share of the country's GAO. If country r 's endowment of factor f relative to the CEE endowment of that factor exceeds country r 's share in the CEE's GAO, i.e. $V_{fr}/V_{fw} > S_r$, then country r is abundant in factor f . The GAO and factor endowment shares by country are reported in Table 2.

The Czech Republic and Estonia are relatively abundant in land. Hungary is relatively scarce in all three factors – labour, land and capital. In contrast, Lithuania and Latvia are relatively abundant in all three factors – labour, land and capital. Poland is relatively abundant in labour and capital. Slovakia is relatively abundant in land and Slovenia is relatively abundant in labour but relatively scarce in land and capital. These estimates are roughly in line with the factor endowment ratios reported in Table 1.

⁴We use this proxy for agricultural labour force for two reasons: (i) it is highly correlated with the unobservable agricultural labour endowment; and (ii) it is exogenous, i.e. it is not determined by farm labour demand in 2004. Moreover, those workers which worked in agriculture until the nineties of the last century are experienced, many of them have agricultural education and, most importantly, they live in rural areas as their competitiveness for manufacturing jobs in cities is limited (Csaki and Lerman 1996). Although a certain share of them has left the rural regions, the worker decision to leave is an endogenous process largely driven by wage differences and employment opportunities. Hence, the current agricultural employment share cannot be considered as a measure of the exogenous comparative advantages. We perform sensitivity analyses using alternatives measures of rural labour endowment (rural population density, rural unemployment rate and rural-urban wage gap). Given that the use of alternative proxies does not change the presented results significantly, they are not reported here for the sake of brevity.

Table 2. Individual CEE country endowment with land, capital and labour relative to all CEE countries

	GAO share	Labour share	Land share	Capital share
Czech Republic	0.131	0.065	0.132	0.088
Estonia	0.014	0.010	0.030	0.014
Hungary	0.157	0.079	0.156	0.109
Lithuania	0.036	0.051	0.080	0.039
Latvia	0.022	0.026	0.045	0.024
Poland	0.572	0.696	0.467	0.680
Slovakia	0.047	0.036	0.074	0.028
Slovenia	0.021	0.037	0.017	0.017
Total CEE	1.000	1.000	1.000	1.000

GAO = Gross Agricultural Output

Source: Authors' calculations based on FADN and Eurostat (2008) data

Relative factor intensities of agricultural production in the CEE

The relative factor endowment differences across countries are especially an important source of comparative advantages if there are sizeable differences in factor intensities among agricultural activities (commodities). Figure 1 shows the differences between various agricultural activities in the relative labour intensity across the CEE. Labour content in percent is measured on the vertical axis and the seven agricultural activities on the horizontal axis.⁵ Dots in the Figure 1 represent 8 CEE countries. The average values for each sector with

the corresponding standard deviations are reported next to the columns.

As shown on Figure 1, labour intensity significantly differs between agricultural activities (commodities) in the CEE. For example, the pig and poultry production (14.6% labour content in agricultural production) is in average 2.4 times more labour extensive than horticulture (34.6% of labour content in agricultural production). Similarly, cereal and oilseed production (17.1% labour content) requires almost two times less labour than permanent crops (33.9%). Hence, the existing differences in the relative factor intensities suggest that there are potential gains from the international specialisation in agricultural production and trade.

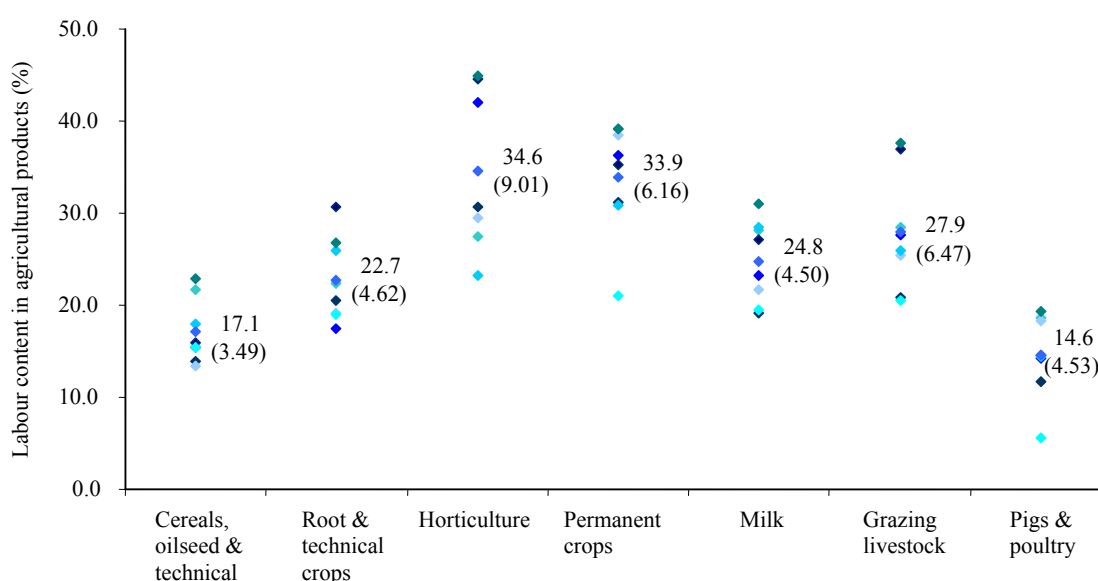


Figure 1. Labour content in agricultural products in the CEE countries

⁵Factor content is defined as the share of input costs in the total production costs. For example, the factor content of labour represents the share of labour costs in the total production costs.

Considering the Heckscher-Ohlin theory, several predictions about the production and trade specialisation in the CEE countries can be made. First, labour abundant Latvia and Lithuania would produce and export products with a relatively high land content, and import products with a relatively low land content. Slovenia has the lowest land endowment per capita, which would suggest the opposite pattern of the factor content of agricultural trade. Second, farm labour abundant countries, such as Poland, which has three times higher agricultural labour endowment than other comparable CEE economies, e.g. Slovenia, would specialise in production and export of relatively labour intensive products relative to their agricultural imports. On the other hand, if other things were equal, agricultural labour scarce countries – the Czech Republic, Slovenia and Slovakia – would import relatively labour intensive goods and export labour extensive agricultural commodities.

Factor content of the CEE agricultural trade

Here we analyse agricultural exports from the CEE to the rest of the world (RoW) (most of which go to the countries of the EU) and imports from the rest of the world (most of which originate from the EU) to the CEE. Second, we examine the factor content hypothesis relating the relative country endowments to factor content of agricultural trade. Given that the CEE countries and the old EU countries are very dif-

ferent, the key underlying assumptions of the HOV theory (equal factor prices, identical technologies, etc.) are not satisfied. Hence, the factor content of agricultural trade between these two groups of countries cannot be analysed in the standard HOV framework. We therefore proceed as follows: (i) we analyse the factor content of the CEE – the rest of the world (RoW) agricultural trade relying on the qualitative analysis; and (ii) we calculate not only the value of the factor content of trade but also the quantity ratios, which may reveal the role of factor price differences between the CEE and the RoW play.

The content of factor services in the gross agricultural trade flows at a disaggregated level are reported in Tables 3 and 4. In both tables, columns 2–4 report the factor content in agricultural imports to the CEE from the RoW; and columns 5–7 report the factor content in agricultural exports from the CEE to the RoW. We use the EU-25 factor intensities in production to obtain the factor shares of the CEE imports in Tables 5 and 6. This is a good approximation given that the most of the CEE trade is with the EU (more than 75%). For exports, we use factor intensities in production of the CEE countries themselves.⁶ Given that agricultural trade is not balanced for all countries in our sample, the factor content is calculated per unit of exports and imports.

There are differences in the factor content ratios computed for exports and imports. In average, the CEE tend to have a higher labour content relative to the capital content in exports than in imports.

Table 3. Factor ratios of agricultural trade in 2004 (in quantities)

	Factor ratios in imports			Factor ratios in exports		
	L/A	L/K	K/A	L/A	L/K	K/A
Czech Republic	13.10	0.87	15.06	7.04	0.90	7.81
Estonia	10.68	0.85	12.54	6.79	1.34	5.07
Latvia	12.54	0.82	15.23	8.40	1.90	4.42
Lithuania	11.39	0.84	13.57	8.74	2.87	3.05
Hungary	11.28	0.76	14.78	9.58	0.82	11.62
Poland	12.26	0.87	14.07	23.36	2.10	11.10
Slovenia	9.65	0.81	11.92	17.58	1.53	11.46
Slovakia	10.58	0.76	13.92	5.92	0.97	6.11
CEE	11.35	0.82	13.80	9.25	1.40	6.60

A = land, L = labour, K = capital

Source: Authors' calculations based on Eurostat (2007), FADN (2008) and GTAP (2008) data

⁶The only exception is the Czech Republic. Due to the unreliable factor price data, we use Slovak factor intensities for the Czech Republic. However, given that both countries shared the same history until 1993, and have a similar farm structure in 2004, using Slovak coefficients should not cause major differences in the factor content of the trade data.

Additionally, the CEE exports possess higher land content relative to capital and relative to labour than the CEE imports. These facts are as predicted by the HOV theory because the CEE countries are abundant in labour and land relative to the EU-25.

For imports, the factor content ratios differ insignificantly among the countries. A relatively stronger cross country variation is observed for the factor content ratios in exports. In particular, Poland and Slovenia have a high labour/capital (low capital/labour) content ratio in exports, while the opposite holds for the Czech Republic and Slovakia. The Czech Republic, Hungary and Slovakia have a low labour/capital ratio (high capital/labour ratio) in exports compared to other countries. According to the HOV theory, the countries with relatively low L/K endowments (Slovenia, Poland in Table 1) should have a low relative L/K content in exports. This is not true, as Slovenia and Poland have a relatively high L/K ratio in exports (Table 3). On the other hand, a low L/K ratio in exports is observed for Slovakia and the Czech Republic and these countries do not possess the relatively high L/K endowments.

In both exports and imports, capital represents the largest factor share, which in average accounts for 58.5% and 49.1% of the export and import value, respectively (Table 4). Agricultural imports of the CEE countries have a higher labour content than exports (45.8% and 39.5%), whereas agricultural exports from the CEE contain more capital than imports to the CEE (58.5% and 49.1%). The third primary production factor land accounts in average for only 2.0% (5.1%) of the export (import) value.

In contrast to the results reported in Table 3, where we account only for the relative factor quantities, in

Table 4, where we account for both the relative factor quantities and factor prices. When factor prices are considered, then the capital/labour ratio is higher in the CEE agricultural exports than in the CEE agricultural imports (labour/capital ratio is lower for exports than for imports). More expensive capital relative to labour in the CEE as compared to the old EU member states reverts the ratio of capital to other factors in trade, when factor content of trade is calculated in values. This finding is in contradiction to the HOV theory predictions.

According to Table 4, the variation of the factor content in imports is rather small across the CEE countries. Similar to Table 5, a stronger variation is observed for exports. Slovakia, the Czech Republic and Slovenia have the highest share of capital content in exports, whereas labour is the largest component of agricultural exports in Estonia, Lithuania and Poland.

Summarising the findings, we may conclude that the HOV theory poorly predicts the factor content of agricultural trade of the CEE countries. Agricultural imports of the CEE countries have a higher labour content than exports (45.8% and 39.5%), whereas agricultural exports from the CEE contain more capital than imports to the CEE (58.5% and 49.1%). This is surprising given the fact that the major trading partner for the CEE countries is the EU-25 which is relatively labour and land scarce and capital abundant. At the country level, the relatively capital abundant countries are observed to export the low capital/labour ratio (Slovenia and Poland), while the relatively labour abundant countries are observed to export the high capital/labour content as measured in quantities (Slovakia). When meas-

Table 4. Factor content shares of agricultural trade in 2004 (in values)

	Factor shares in imports			Factor shares in exports		
	land	labour	capital	land	labour	capital
Czech Republic	4.68	47.65	47.66	1.50	28.64	69.86
Estonia	5.43	46.12	48.46	0.67	56.09	43.24
Latvia	4.70	46.40	48.89	1.21	42.00	56.79
Lithuania	5.24	46.44	48.31	2.36	46.82	50.81
Hungary	4.96	44.13	50.90	1.99	37.01	61.00
Poland	5.04	47.41	47.56	3.05	46.84	50.11
Slovenia	5.68	44.80	49.52	3.83	30.80	65.37
Slovakia	5.31	43.06	51.63	1.67	27.46	70.88
CEE	5.13	45.75	49.12	2.03	39.46	58.51

Notes: For each country, the sum of shares normalised to 1

Source: Authors' calculations based on the Eurostat (2007), FADN (2008) and GTAP (2008) data

ured in the value terms, again Slovakia, the Czech Republic and Slovenia have the highest share of the capital content in exports, whereas labour is the largest component of agricultural exports in Estonia, Lithuania and Poland. These findings do not confirm the HOV theory.

Many reasons are identified in the literature why the HO theory does not provide good predictions about international trade. In the next section, we argue that the key underlying assumptions (equal factor prices, identical technologies, etc.) of the HOV theory are not satisfied. A special attention is paid to the differences in technologies stemming from the organisation of farm production in the CEE.

RICARDIAN THEORY AND AGRICULTURAL TRADE IN THE CEE

Organisation of farm production in the CEE

There are significant differences in the organisation of farm production between the transition countries of the Central and Eastern Europe (CEE). Agricultural sector in some countries is dominated by large corporate farms, whereas in other countries, small individual farms cultivate most of the land. These cross-country differences in the farm organisation in the CEE countries are summarised in Table 5, which reports the percentage shares of land cultivated by the IF and their share in the total agricultural output. The last column of Table 5 reports the average farm size in hectares. Slovenia and Poland have the highest share of IF in both land use and in agricultural

output, while Slovakia and the Czech Republic have the lowest share of IF.

The structure of the farms in the CEE countries is the outcome of the communist policies that were in effect until 1990, as well as of the policy decisions made in the early years of transition with respect to privatisation and restructuring of farms. The transition process that started in 1990s involved changes of both formal and informal rules. In general, a higher speed is observed in transition of the formal rules, while changes of the informal rules were relatively slow-paced. The informal rules, however, have strong implications for the effectiveness of the sector and transaction costs (Csaki and Lerman 1996).

Agricultural land was mainly cultivated collectively during the communist times. Land privatisation was therefore a significant step towards market economy (Kancs and Weber 2001). Farm restructuring followed after the privatisation process. New private owners of farm assets and land were allowed to break away from the cooperative farms and to start individual farming. This led to the creation of many individual farms that were significantly smaller in size than the cooperatives, but comparable to their Western European or American counterparts. But not all cooperative farms broke up into individual farms. Many cooperatives (those not entirely replaced by individual farms) were transformed. That is, the old socialist cooperatives were turned into the corporate type farms such as joint-stock companies, limited-liability companies or partnerships.

Depending on the methods of privatisation and government policies on restructuring, different farm structures emerged in different transition countries.

Table 5. Farm structure in CEEC

	Year	Family farms		Corporate farms	
		share of TAA (%)	average size (ha)	share of TAA (%)	average size (ha)
Czech Republic	2003	28	20	72	937
Hungary	2000	59	4	41	312
Poland	2003	87	8	13	–
Slovakia	2003	12	42	88	1 185
Slovenia	2000	94	–	6	–
Estonia	2001	63	2	37	327
Latvia	2001	90	12	10	297
Lithuania	2003	89	4	11	483

TAA = Total Agricultural Area

Sources: Bulgaria: Bulgarian Ministry of Agriculture and Forestry; Czech Republic: Czech Statistical Office; Estonia: Statistical Office of Estonia; Hungary: European Commission; Poland: Central Statistical Office; Latvia: Statistical Office of Latvia; Lithuania: Statistical Office of Lithuania; Slovenia: Statistical Office of the Republic of Slovenia

While in Slovakia and the Czech Republic agriculture is still dominated by large transformed enterprises, Latvia, Lithuania and Estonia have created many small size individual farms. There is a whole spectrum of farm structures in between these two extreme cases (Table 5).

Literature from the 1990s predicted that the large cooperative farms in the CEEC would transform into the individual farms and that the farm structure in the CEEC would become similar to that in the Western Europe and the USA. It was perceived that the IF are more efficient than the CF (Schmitt 1991; Csaki and Lerman 1996; Kancs and Weber 2001). This transformation has not occurred in all CEE countries, however. Ciaian and Swinnen (2006) provide a partial equilibrium theoretical model that explains why CF persist in the CEE. According to them, the large scale CF continue to use a large part of land because the emerging individual farms face significant transaction costs to obtain land from the established CF. Transactions costs include costs involved in bargaining with the farm management, in obtaining information on land and tenure regulations, in implementing delineation of the land and dealing with the inheritance and

co-owners (Prosterman and Rolfes 1999; Ciaian and Swinnen 2006).

Farm organisation, technology and specialisation

In terms of farm specialisation and factor content of agricultural trade, the share of IF and CF is important because the relative factor requirements in producing the same product are different between the CF and IF. In other words, the IF use a different technology than the CF. The empirical evidence for the CEE is summarised in Table 6, which reports the labour-capital ratio in the CF and IF farm output by agricultural commodity in 2004. Columns 2 and 3 report the capital/labour ratio in the IF and CF output, respectively. The last column reports the relative factor intensity of the IF compared to the CF.

The relative factor intensity estimates reported in column 4 suggest that in the CEE transition countries, the IF use less capital compared to the CF, whereas CF use less labour compared to the IF (Table 6). The IF use more labour per unit of capital in production

Table 6. Capital/labour intensity in agricultural production by commodity and by farm type in 2004

Agricultural commodity	$(K/L)_I$	$(K/L)_C$	$K/L)_I/(K/L)_C$
Specialist cereals, oilseed and protein crops	3 789.7	6 266.2	0.60
Specialist other fieldcrops	3 433.2	3 651.6	0.94
Specialist horticulture	3 173.6	3 350.3	0.95
Specialist wine	3 417.6	4 192.2	0.82
Specialist orchards – fruits	4 003.6	4 175.6	0.96
Specialist olives	4 872.9	na	na
Permanent crops combined	2 246.1	2 654.8	0.85
Specialist milk	2 543.7	2 731.0	0.93
Specialist cattle-rearing and fattening	2 500.4	4 445.2	0.56
Cattle-dairying, rearing and fattening combined	2 200.0	2 261.2	0.97
Specialist sheep and goats	2 311.4	4 049.8	0.57
Specialist granivores	2 950.3	2 974.0	0.99
Mixed crops	2 355.8	2 734.0	0.86
Mixed livestock, mainly grazing livestock	1 751.8	2 483.9	0.71
Mixed livestock, mainly granivores	1 983.4	4 619.3	0.43
Field crops-grazing livestock combined	2 383.2	2 628.6	0.91
Various crops and livestock combined	2 575.2	2 826.2	0.91

$(K/L)_I$ = capital/labour ratio in IF output, $(K/L)_C$ = capital/labour ratio in CF output, $(K/L)_I/(K/L)_C$ = relative factor intensity of IF compared to CF.

Source: Authors' calculations based on the FADN (2008) data

of all agricultural commodities. The column $(K/L)_I / (K/L)_C$ of Table 6 shows that technological differences between the IF and CF differ between agricultural commodities. The most sizeable technological differences in the terms of factor use are estimated for mixed livestock, where the relative content of capital to labour in output of the IF amounts only to 43% of capital to the labour content in output of the CF. In contrast, pig and poultry production (specialist granivores) is nearly equally capital intensive between the IF and CF – the IF output contains 2950.3 EUR of capital per 1 worker, while the equal CF output contains 2974.0 EUR of capital per 1 worker.

From the above, it follows that there are differences in technology used by the IF and CF. The IF use more labour intensive technologies, while the CF use more capital intensive technologies. This also confirms the findings from the previous literature (e.g. Pollak 1985; Allen and Lueck 1998; Ciaian et al. 2009).

Technological differences between the IF and CF and high transaction costs of adjusting the farm organisation (from IF to CF and vice versa) are reflected in different specialisation patterns between the IF-dominated and the CF-dominated countries. The technology based Ricardian theory of international trade would therefore predict that the countries with a high share of IF (Slovenia and Poland) would produce and export relatively labour intensive products and import products with a relatively high capital content. In contrast, *ceteris paribus*, we would expect that the countries with a high share of CF (Slovakia and the Czech Republic) would produce and export

relatively more capital intensive goods and import relatively more labour intensive goods.

THE ROLE OF FACTOR ENDOWMENTS AND PRODUCTION TECHNOLOGY IN DETERMINING AGRICULTURAL TRADE IN THE CEE: PREDICTIONS OF THE HO AND RICARDIAN THEORIES

In the previous sections, we have determined two potential determinants of agricultural production and trade in the CEE: factor endowments and technology. The findings are summarised in Figure 2, which positions countries according to their technological advantages stemming from the farm organisation and the relative labour endowment advantages.⁷ Those countries, which are located in the upper part of Figure 2 (Slovenia and Poland) have a high share of IF that use labour intensive technologies, whereas those countries located at the bottom in the Figure 2 (the Czech Republic and Slovakia) are dominated by the labour extensive CF. Furthermore, the most agricultural labour scarce countries are located on the left hand side in the Figure 2 (the Czech Republic, Slovenia and Slovakia), whereas the most agricultural labour abundant countries (Poland) are located on the right hand side of the Figure 2.

It means that Poland has both technological and factor endowment advantages in labour intensive products. Compared to the other CEE countries, the Czech Republic and Slovakia have strong technological

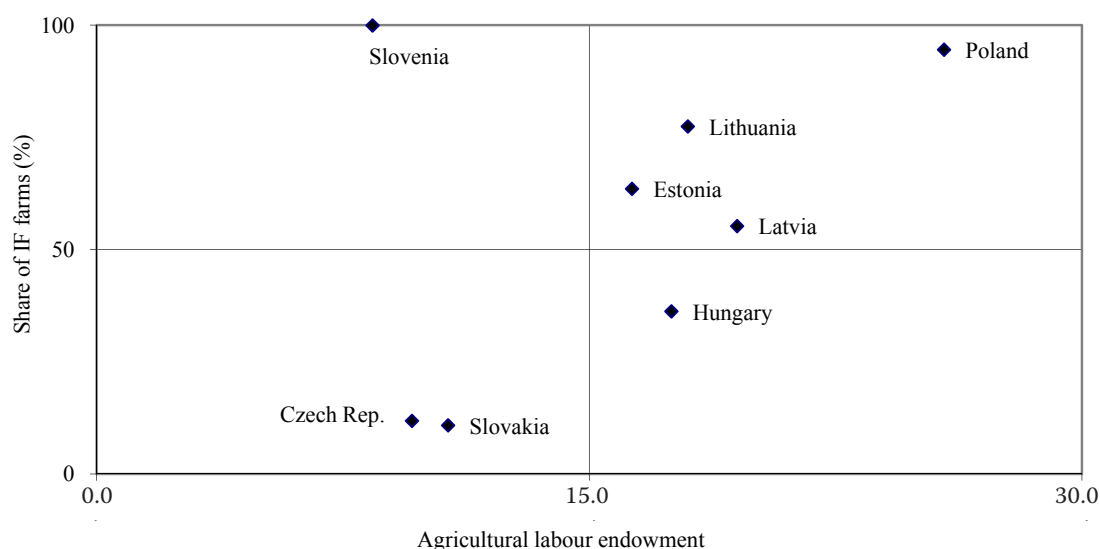


Figure 2. Comparative advantages of farm organisation and labour endowment

⁷ Similar figures can be drawn for the other two primary factors, capital and land. Given that the country advantages in capital are inversely related to labour, they are not reported here for the sake of brevity.

disadvantages and some endowment disadvantages in labour intensive agricultural products. Slovenia has strong technological advantages and some endowment disadvantages in labour intensive products. The comparative advantages of Hungary are just the opposite of Slovenia. The remaining group of countries, the Baltic states, which are located in the central part of Figure 2, has slight labour endowment advantages, but it does not have pronounced technological advantages/disadvantages in labour intensive agricultural industries.

Based on these findings, the Ricardian and the HO theories of international trade suggest that agricultural exports of countries with comparative advantages in labour intensive products (e.g. Poland) would contain a lower capital/labour ratio than agricultural exports of countries with comparative advantages in capital intensive products (e.g. the Czech Republic and Slovakia). This is our empirical hypothesis, which we will examine in the following section.

In this section, we provide a first attempt to explain these peculiarities observed in the CEE agricultural trade. In particular, we aim at assessing the role of market imperfections and transaction costs. Given that neither market imperfections nor transaction costs are observable, we need to account for them indirectly. Moreover, our sample size (eight observations) does not allow for performing a formal testing of the role of market imperfections and transaction costs.

Therefore, we adopt a qualitative analysis approach to investigate the potential role of farm organisation in the factor content of agricultural trade. More precisely, in order to examine the relationship between the farm organisation and the factor content of agricultural trade, we plot the share of land used by IF (x axis) against the ratio of labour/capital quantity in trade to labour/capital endowments (Figure 3) and the share of land used by IF (x axis) against the ratio of labour/capital costs in trade to labour/capital endowments (Figure 4) on the y axis. Our null hypothesis is that the farm organisation is fully endogenous and hence it does not affect the factor content of agricultural trade.

Figure 3 shows how the farm organisation affects the relative factor content of agricultural trade in the CEE. In Figure 3, the ratio of labour to capital content in exports and imports is represented in quantities, whereas in Figure 4, it is in values (costs). In other words, the difference is that Figure 4 takes into consideration the differences in input quantities and input prices in exports and imports, whereas Figure 3 accounts only for the differences in input quantities in exports and imports in the CEE.

The results reported in Figures 3 and 4 suggest that when controlling for endowments (in terms of labour/capital endowment ratio) the farm organisation is an important determinant of the factor content of agricultural trade. Hence, the farm structure co-determines the type of products (in terms of labour/

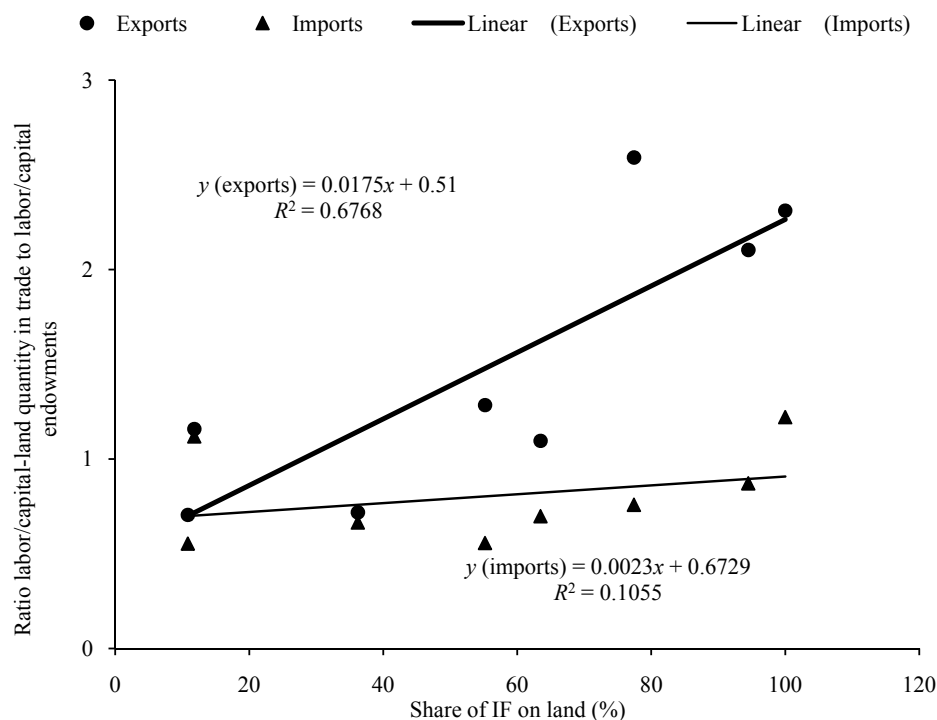


Figure 3. Relationship between farm organisation and labour to capital quantity in trade

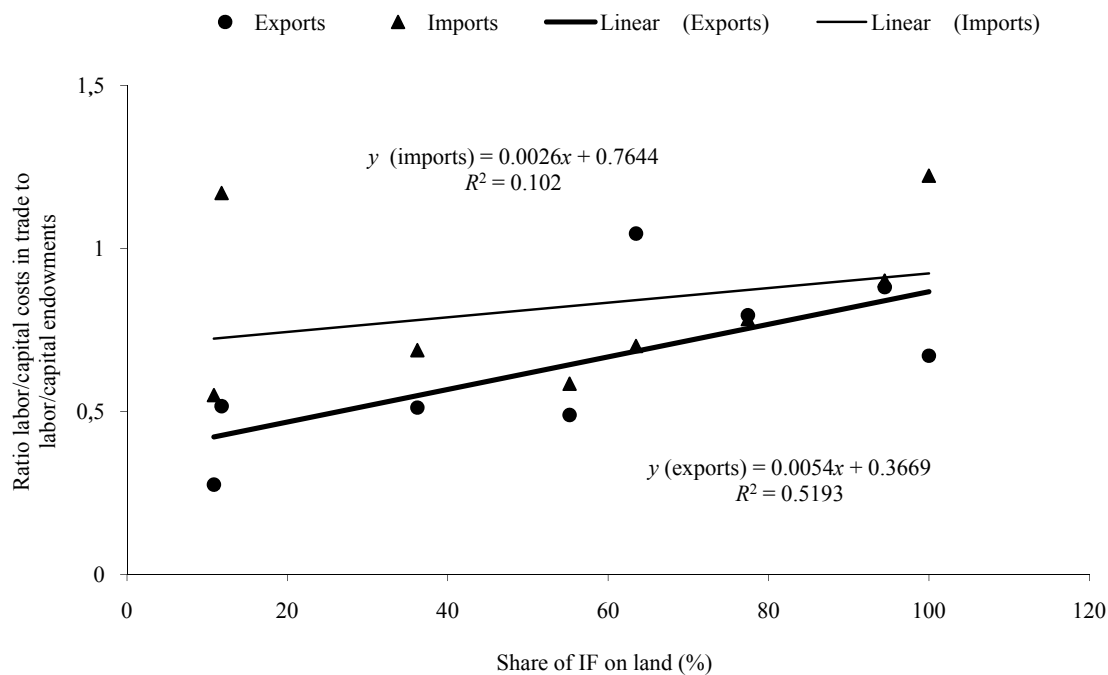


Figure 4. Relationship between farm organisation and relative labour to capital value in trade

capital intensity) that the CEE countries export and import. A higher share of IF in the land use implies a higher share of labour content of exports. The sign for exports is in line with our expectations. Our theoretical hypothesis suggests the opposite sign for imports – the countries with the IF dominance should import more capital intensive products. However, our results for imports reported in Figures 3 and 4 do not confirm this hypothesis. The relationships for imports have the same sign as for exports. However, the correlation is insignificant for imports.

The wrong sign for imports might be due to the fact that we use the EU-25 factor intensities in production to obtain the factor shares of the CEE imports. In fact we use the EU-25 technology characterized by the overwhelming dominance of individual farms and combine it with the CEE imports which are determined by other factors which we do not control here. For example, some agricultural commodities cannot be produced in the CEE countries due to climatic conditions and must be imported from the EU-25, or there are differences in consumers' preferences, market size effects (through the number of available varieties to consumers) and other differences in the consumer behaviour, which are neglected in the present study.

Generally, the relationship is considerably stronger for exports than for imports (for exports $R^2 = 0.68$ and 0.52 , whereas for imports $R^2 = 0.11$ and 0.10). When represented in quantities (Figure 3), the correlation between the farm structure and the factor content of imports is approximately equal as the correlation

when imports are represented in values (Figure 4). For exports, there is some difference between the two correlations. When taking into consideration only quantities, the correlation is somewhat stronger (Figure 3) than if accounting for both input quantities and input prices. This indicates that the input price differences may have some offsetting effect to the farm organisation in determining the factor content of exports.

CONCLUSIONS

The objective of the present paper was to examine the factor content of the CEE transition country agricultural trade. In addition, the paper attempts to identify the potential role of transaction costs and market imperfections in farm organisation and trade specialisation. It is one of the first attempts: (i) to examine the factor content in the CEE agricultural trade; and (ii) to examine how transaction costs and market imperfections may affect the relative factor content of the CEE agricultural trade.

Drawing on the COMEXT, GTAP and FADN data for 2004, we found that there are differences in the factor content of agricultural trade between the individual CEE countries and between the CEE and the old EU member states. At the country level, the factor content between exports and imports is rather similar in the CEE agricultural trade flows. In both exports and imports, the largest factor share is represented by capital, which in average accounts for

49% of imports and 59% of exports. These results are new and have not been reported for the CEE in the literature before.

Analysing the potential role of transaction costs and market imperfections, we found some evidence that transaction costs and market imperfections may indeed co-determine the farm organisation and sectoral specialisation, and hence the factor content in agricultural goods. Our empirical findings suggest that when controlling for endowments (in terms of labour/capital endowment ratio), the farm organisation is an important determinant of the factor content of agricultural trade. Therefore, the farm structure co-determines the type of products (in terms of labour/capital intensity) the CEE countries export and import. A higher share of IF in the land use implies a higher share of the labour content of exports and imports. However, these first results need to be verified econometrically, in order to draw general conclusions about the relationship between the factor content in production and trade, and transaction costs in farm organisation and sectoral re-specialisation.

The results of this paper have also implication for the competitiveness of food processing industry in the CEE. Our results indicate that transaction costs of farm reorganisation may lead to the divergence in location and specialization of food industry across the CEE countries. Competitiveness of a particular agricultural commodity in a given country represents a pull factor for food companies which use this commodity as an input in their production process. For example, the CEE countries with the farm structure dominated by IF are productive in labour intensive agricultural commodities, such as horticulture and permanent crop, indicating that they may attract food companies which specialise in processing these commodities. This type of food companies may prefer to locate their production facilities in the IF dominated countries because of lower input costs. On the other hand, the CEE countries with the CF predominant may attract other type of food processing companies, in particular those that process capital intensive agricultural commodities.

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REFERENCES

- Abo-Zaid M.S. (2010): Sticky Wages, Incomplete Pass-Through and Inflation Targeting: What is the Right Index to Target? *Journal of Economics and Econometrics*, 53: 28–58.
- Allen A., Lueck D. (1998): The nature of the farm. *Journal of Law and Economics*, 41: 343–386.
- Bojnec S., Ferto I. (2008): European enlargement and agro-food trade. *Canadian Journal of Agricultural Economics*, 56: 563–579.
- Bojnec S., Ferto I. (2006): Comparative Advantages and Competitiveness of Hungarian and Slovenian Agri-Food Trade in the EU Markets. In: 98th EAAE Seminar Marketing Dynamics within the Global Trading System: New Perspectives. Chania, Crete, Greece, 29 June–2 July.
- Bowen H.P., Leamer E.E., Sveikauskas L. (1987): Multi-country, multifactor test of the factor abundance theory. *American Economic Review*, 77: 791–809.
- Campbell L.D. (2010): History, Culture, and Trade: A Dynamic Gravity Approach. EERI Research Paper Series No 10/26, Economics and Econometrics Research Institute, Brussels.
- Ciaian P., Swinnen J.F.M. (2006): Land market imperfections and agricultural policy impacts in the new EU Member States. *American Journal of Agricultural Economics*, 88: 799–815.
- Ciaian P., Pokrivcak J., Drabik D. (2009): Transaction costs, agricultural production specialisation and farm structure in Central and Eastern Europe. *Post-Communist Economies*, 21: 193–203.
- COMEXT (2004): External Trade Statistics Database. European Commission and Eurostat.
- Csaki C., Lerman Z. (1996): Agricultural Transformation in Central and Eastern Europe and the Former USSR: Issues of Land Reform and Farm Restructuring. Paper In: VIIIth Congress of the European Association of Agricultural Economists, Edinburgh.
- Davis D.R., Weinstein D.E. (2001): An account of global factor trade. *American Economic Review*, 91: 1423–1453.
- Eurostat (2007): Intra- and extra-EU trade – Annual data, CN – Supplement 2/2007, (DVD-ROM), Luxembourg.
- Eurostat (2008): Europe in Figures – Eurostat Statistical Yearbook 2008. Luxembourg.
- FADN (2008): The Farm Accountancy Data Network. European Commission. Available at <http://ec.europa.eu/agriculture/rca>
- Feenstra R.C. (2004): *Advanced International Trade*. Princeton, Princeton University Press; ISBN 0-691-11410-2.
- Ferto I. (2005): Vertically differentiated trade and differences in factor endowment: The case of agri-food products between Hungary and the EU. *Journal of Agricultural Economics*, 56: 117–134.
- GTAP (2008): GTAP 7 Data Base, December 2008.

- Kancs D. (2007): Trade growth in a heterogeneous firm model: Evidence from South Eastern Europe. *World Economy*, 30: 1139–1169.
- Kancs D., Ciaian P. (2010a): Factor content of bilateral trade: the role of firm heterogeneity and transaction costs. *Agricultural Economics*, 41: 305–317.
- Kancs D., Ciaian P. (2010b): Factor content of agricultural trade in a generalised three factor model. *Journal of International Agricultural Trade and Development*, 6: 97–126.
- Kancs D., Weber G. (2001): Modelling Agricultural Policies in the CEE Accession Countries. EERI Research Paper Series No 01/02, Economics and Econometrics Research Institute, Brussels.
- Kielyte J. (2008): Estimating panel data models in the presence of endogeneity and selection. *Journal of Economics and Econometrics*, 51: 1–19.
- Koo W.W., Anderson C. (1988): Effects on Resource Endowments on Agricultural Trade. *Agricultural Economics Report No. 239*. Department of Agricultural Economics, North Dakota University.
- Leamer E. (1980): The Leontief paradox reconsidered. *Journal of Political Economy*, 88: 495–503.
- Leamer E. (1984): *Sources of International Comparative Advantage: Theory and Evidence*, MIT Press, Cambridge.
- Lee C., Wills D., Schluter G. (1988): Examining the Leontief paradox in U.S. agricultural trade. *Agricultural Economics*, 2: 259–272.
- Leontief W.W. (1953): Domestic Production and Foreign Trade; the American Capital Position Re-Examined. *Proceeding of the American Philosophical Society*, 97: 332–349.
- Mitze T. 2010. Estimating Gravity Models of International Trade with Correlated Time-Fixed Regressors: To IV or not IV? EERI Research Paper Series No 10/22, Economics and Econometrics Research Institute, Brussels.
- Pollak R.A. (1985): A transaction costs approach to families and households. *Journal of Economic Literature*, 23: 581–608.
- Prosterman R.L., Rolfes L. (1999): Review of the Legal Basis for Agricultural Land Markets in Lithuania, Poland and Romania. In: Csaki C., Lerman Z. (eds.): *Structural Change in the Farming Sectors in Central and Eastern Europe: Lessons for the EU Accession*. Washington DC, World Bank; ISBN 978-0-8213-4733-1, pp. 110–139.
- Qineti A., Rajcaniova M., Matejkova E. (2009): The competitiveness and comparative advantage of the Slovak and the EU agri-food trade with Russia and Ukraine. *Agricultural Economics – Czech*, 55: 375–383.
- Rashid A., Razzaq T. (2010): Estimating Import-Demand Function in ARDL Framework. EERI Research Paper Series No 10/15, Economics and Econometrics Research Institute, Brussels.
- Schluter G., Lee G.K. (1978): Is Leontief's Paradox applicable to U.S. agricultural trade? *Western Journal of Agricultural Economics*, 3: 165–171.
- Schmitt G. (1991): Why is the agriculture of advanced Western countries still organised by family farms? Will this continue to be so in the future? *European Review of Agricultural Economics*, 18: 443–458.
- Schott P. (2003): One size fits all? Heckscher-Ohlin specialisation in global production. *American Economic Review*, 93: 686–708.
- Stern R. (1975): Testing trade theories. In: Kenen P. (ed.): *International Trade and Finance: Frontiers for Research*. Cambridge University Press, New York; ISBN 9780521068741.
- Svatoš M., Smutka L. (2010): Development of agricultural foreign trade in the countries of Central Europe. *Agricultural Economics – Czech*, 56: 163–175.
- Trefler D. (1993): International factor price differences: Leontief was right. *Journal of Political Economy*, 101: 138–160.
- Trefler D. (1995): The case of the missing trade and other mysteries. *American Economic Review*, 85: 1029–1046.
- Vanek J. (1959): An afterthought on the real-cost-opportunity cost dispute and some aspects of general equilibrium under conditions of variable factor supplies. *Review of Economic Studies*, 26: 198–208.
- Vanek J. (1968): The factor proportions theory: the N-factor case. *Kyklos*, 4: 749–756.
- World Bank (2005): *From Disintegration into Reintegration: Eastern Europe and the Former Soviet Union in International Trade*. The World Bank, Washington D.C.; ISBN 978-0821361979.

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